CONTRIBUTION TO THE SURGERY OF CEREBRAL TUMORS.

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A ROBUST, finely formed man, A. P. æt. 33 years, was referred to me for surgical treatment, in October, 1888, by his physician, Dr. Chas. Corey, in consequence of mental and convulsive symptoms which had gradually developed after a blow on the head, for which reason it was hoped that operative interference might be successful in relieving them. The history as then ascertained was as follows:

In the spring of 1882 he was thrown from a carriage and struck his head on a curbstone. There is no record of the immediate effects of the injury, but he certainly had no paralysis following it. In the year following it he was noticed to have become more irritable, childish and apathetic in character, quite in contrast to his condition before the injury. In the fall of 1884, about two and a half years after the injury, he first had a convulsion. This was general in character. The brother says that he fell down stairs in it. Became unconscious and "blind."

He had several of these at intervals of about a month with frequent intermediate attacks of petit mal. This continued for about a year, when he took a patent epilepsy cure and remained free of convulsions till June, 1888. He had continued to have, however, at rare intervals, the petit mal attacks, in which he became more or less unconscious or dizzy, with staring eyes, but no convulsive movements.

In June, 1888, he had another severe convulsion with loss of consciousness for half an hour or more. Since then he has had no severe attacks, but has had abortive or mixed attacks very often, sometimes several daily. He has also suffered from attacks of severe frontal and vertical headaches, but without nausea or vomiting. He has become very apathetic, never volunteers to speak, and only answers in the briefest way. He will sit quietly in a chair nearly all the time. He does not get maniacal or show delusions. His sleep is disturbed (by headaches and the attacks)? His appetite is fair, and his bowels very constipated. His bodily functions are performed as are those of an infant, without regard to surroundings and without attempts at cleanliness.

Oct. 13, 1888. An ophthalmoscopic examination was made by Dr. Arthur Mathewson, who reported vision of about $^{20}/_{200}$, with very much swollen condition of both optic nerves, "choked disks." Upon these appearances Dr. M. expressed the opinion that some coarse intracranial lesion, probably tumor, was present, but expressed no opinion as to localization.

Oct. 16, 1888. An examination was made by Prof. C. L. Dana, who reported as follows:

The patient is strongly built, walks rather slowly, and with a little limp or sign of stiffness on the right side. He answered questions sometimes correctly and sometimes not. Often he seems unable to understand the simplest directions. His face shows no paresis. The tongue is protruded straight. The arms are weak; right hand 35, left 30; a slight tremor shows in each equally. The tremor increases on volitional movement. The reflexes are a little exaggerated, but there is no inco-ordination. The legs show also slightly exaggerated reflexes, but no ankle clonus. The right knee-jerk is somewhat greater than the left. There is no evidence of ataxia, but on making him walk with closed eyes he tends toward the left. The lower limbs are fairly strong and the patient can walk at least half a mile.

The patient's hebetude is so great that it is impossible to be certain whether there is any tactile or pathic anæsthesia; if present, it is slight.

There is some unequal innervation of the eye muscles. The patient occasionally looked cross-eyed to the right. Special tests failed to find any special paresis. Pupils equal, responding to light and accommodation. Impossible to tell positively whether there is any hemianopsia, or restricted visual field; probably not. The sense of hearing is good in each ear.

The patient, though he spoke little, did not seen to have any aphasic disturbances. The record would be as follows: Aphemia, none; agraphia, present—he could not write, but probably from his utter imbecility; word-blindness, his difficulty in reading ought to be due chiefly to visual defect; though at times he did not seem to comprehend the simplest questions or directions.

The patient, while seated, would be constantly yawning or stretching. He had the peculiar physiognomy of cases of intracranial tumor.

Examination of the head showed an old scar just below the left parietal boss (See Fig. 1). This would place it over the angular gyrus or adjacent part of the posterior t em [illegible]

Description of abortive epileptic attack. One of these attacks came on in the consulting room of Prof. Dana. The patient uttered no cry and made no decisive movement. The pupils dilated; the head and eyes turned to the left: the right leg straightened, the right hand closed and the forearm flexed. These movements were not clonic, or even strongly tonic The fingers could be unbent and the arm straightened. The patient was not, strictly speaking, conscious, yet he responded to questions slightly. The movements would last a minute, then change, the patient moving restlessly in the chair. The face was not changed in color. After about ten minutes the attack ceased, the patient stood up and said he felt all right. He did not remember what had occurred.

Upon the recommendation of Prof. Dana, the patient was given potassium iodide, beginning with 15 grains three times daily, and increasing five grains daily until a maximum dose of one drachm three times daily was reached. This treatment was maintained for 15 days without effect other than an aggravation of all his symptoms. Medicinal treatment was therefore suspended, and the patient was admitted into the Methodist Episcopal Hospital, Nov. 5, for further observation, and operation if it should be deemed best.

Nov. 7. An extended examination was made by Dr. W. W. Browning, with results merely corroborating those already reported by Prof. Dana.

A positive opinion was expressed by both these neurological experts that a tumor of the brain existed in this case. Its localization however could not be definitely made from the symptoms presented. These symptoms, also, they were of opinion were not inconsistent with the existence of a tumor in the angular gyrus, or its immediate vicinity, being the site where previous injury was known to have been sustained. In view of the hopeless condition of the man, and the positiveness of the diagnosis as to the character of the disease, an exploratory operation at the point of injury was both deemed justifiable and recommended.

During the few days that intervened between the reception of the patient in the hospital, and the operation that was done upon him, no special change in his condition was noted. He slept and ate well; he lay or sat apathetically wherever he was placed; he was tractable; he urinated and defæcated in bed or wherever he might be when the desire came upon him; the convulsive seizures were frequent.

Notwithstanding the indefiniteness of the localizing symptoms I determined to submit him to operation, choosing the site of the known external injury for the attack, for the following reasons:

1. Injuries of the skull are a recognized cause of the development of diseased growths in the brain. 2. The location of such tumors usually corresponds to the site of the previous skull injury. 3. The patient, except as regards his animal functions, was already practically dead, and the hopelessness of the prognosis made justifiable the assumption of extreme risks, provided they were attended with the slightest possibility of advantage to him. Accordingly, Nov. 9, 1888, I proceeded to operate as follows: In the operation I was assisted by Dr. J. B. Bogart and the house-staff of the hospital, there being present also many of my colleagues of the hospital staff and also Drs. Corey, Dana, Shaw and Browning, who were interested in the neurological aspects of the case. The patient's scalp had been shaven two days previously, and thoroughly scrubbed and disinfected. The fol-

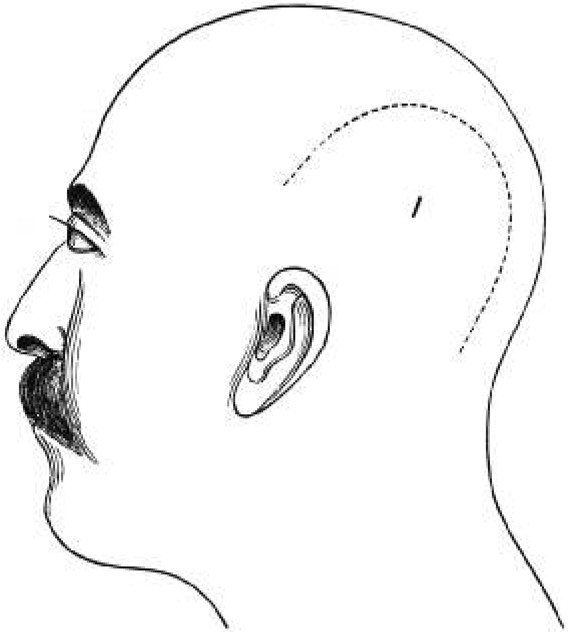

FIG. 1. SHOWING SITE OF OLD CICATRIX AND LOCATION AND CHARACTER OF THE PRIMARY SCALP INCISION.

lowing antiseptic precautions were adopted: All instruments boiled. Absorbent dressing materials boiled. Usual antiseptic precautions to the field of operation and to the hands of the operators.

A curved incision was made, convexity upwards; beginning at the mid-temporal region, it was carried upwards and backwards to within an inch and three quarters of the sagittal suture, then downwards and backwards so as to make a flap four inches across at its base and four inches from above downwards (Fig. 1), at the centre of which was the scar of injury. Hemorrhage was controlled at the edges of the flap by pressure forceps; from scalp edges by rapidly applied sutures, forming temporary mass ligatures (Fig. 2). The periosteum was included in the flap, which was then reflected downwards, exposing the denuded cranial wall. A one inch trephine was applied to the parietal bone at the point which lay under the scalp cicatrix, which point had been marked by punctures with a drill previous to the reflection of the flap. The cranial vault presented no depression, nor other sign of previous injury. The first button of bone having been removed a second similar one was removed behind it and on the same level with it. The

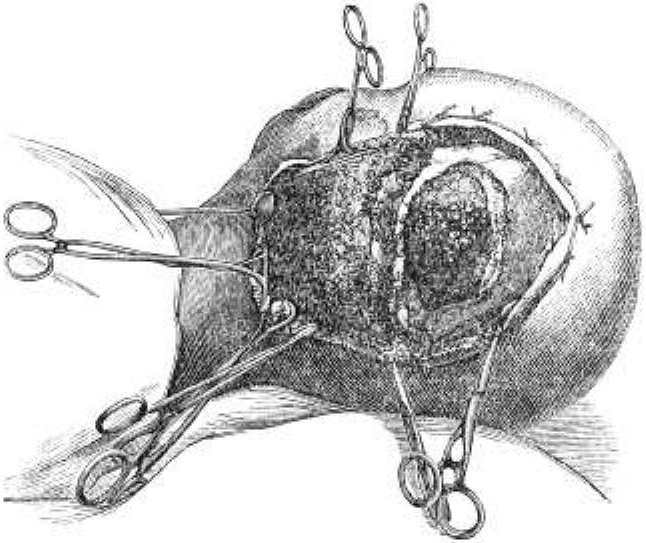

FIG. 2. SHOWING FLAP REFLECTED, CRANIAL WALL OPENED, AND BRAIN PROTRUDING, (from a photograph.)

opening thus made was further enlarged by the removal of a three quarter inch button of bone above and below the points of intersection of the two first trephine openings. Projecting angles were removed with a rongeur so as to convert the whole opening into an oval opening with smooth edges. The buttons and bone fragments as removed were placed in recently boiled distilled water, the receptacle containing which was kept in a warm water bath. The dura mater thus exposed was normal in appearance, projected into the opening tense, and without pulsation. It was divided throughout the lower three-fourths of the circumference of the opening and the flap reflected upwards, the section being made three sixteenths of an inch from the edge of the opening in the bone. Immediately on the reflection of this flap, the brain substance projected strongly through the opening with such force as to tear the cortical portion at the anterior margin of the opening, making a rent a quarter of an inch deep.

The tissue presenting being normal and the intracranial pressure evidently being in front of the point of opening in the cranial wall, the opening was enlarged toward the front by the removal of another inch button and by the rounding off of the corners by the rongeur as before. The dura was reflected as before. There was now an opening through the cranial wall oval in shape, three inches in its antero-posterior diameter by two and a half from above downwards. Through this the brain tissue projected, forming a tumor the size of half an egg, without pulsation, normal in appearance. (Fig. 2.) Palpation elicited no evidence of deep seated induration. Careful separation in the line of the sulci was negative in its results. With the advice of the neurological experts present a delicate exploring trocar and needle was passed into the brain tissue in various directions, the furthest excursion of the needle being posteriorly two and a half inches and anteriorly three and a half inches. The result of these explorations was negative. As the needle was passed anteriorly to a depth of about two inches, a sense of slight elastic resistance was perceived which was overcome with slight pressure after which the needle passed on as before. This elastic resistance was due, as was afterwards plainly demonstrated, to the pia mater covering in the surface of the convolutions in the fissure of Sylvius, which was transfixed by the needle. It being now abundantly demonstrated that there was no tumor in the region of the brain accessible from the point of operation, further attempts at exploration were suspended.

The projecting cerebral mass was so great in volume and so tense, that there was no possibility of returning it within the cranial cavity, nor of covering it by the dural flaps. Accordingly, after due consultation with colleagues present, it was sliced off down to the level of the bone. Slight hemorrhage from minute arterioles in the pia was arrested by delicate catgut ligatures, the adjustment of which was attended with much difficulty owing to the delicate and fragile nature of the tissues. It was finally, however, satisfactorily done. The flaps of dura were now brought down into place and secured by catgut sutures to the cut edge of the peripheral dura. A gap between the flaps was left amounting to about one fourth of the opening. Upon the surface of the dura, the parts having been thoroughly cleansed by irrigations of warm distilled water, were now placed four of the buttons of bone, two large and two small, which had been kept warm and sterile up to this moment. Two fine rubber drains were placed so as to reach from the interval between the dural flaps to the lower posterior angle of the scalp wound.

The pressure forceps were now, one by one, removed from the scalp flap, any vessels still requiring ligature were secured and the flap laid up in place and secured by sutures throughout its whole extent, except at the point of emergence of the drainage tubes.

The parts were enveloped in a mass of gauze, which had been sterilized by boiling. The entire time occupied by the operation was two hours and a half. At the close of operation, the patient exhibited considerable shock. Pulse 152.

Under the use of digitalis and alcohol, and external heat he rallied slowly. As the effects of the anæsthetic passed off, paralysis of right arm and leg was noticeable.

7:30 P.M. Pulse 123. Ordered enemata of beef peptonoids.

11:25 P.M. Temperature 100°. Pulse 120.

Nov. 10, 8 A.M. Lies in a quiet stupor. When spoken to sharply, appears to recognize what is said. Takes nourishment by the mouth and retains it.

2 P.M. Begins to rub abdomen as if in pain. During the remainder of the afternoon was quite restless. At midnight pulse has risen to 160.

Nov. 11, 1 A.M. Breaths heavily. Hand wanders constantly to head.

2:30 A.M. Unable to swallow.

3 A.M. Great dyspnœa has developed. Beginning œdema pulmonum. Dry cups over chest. The œdema of lung progressed in intensity and extent, pulse weak and 160.

7:30 A.M. Death by respiratory failure, 38 hours after completion of operation.

Autopsy.—Five hours after death. Report of Dr. Hodenpyl, the pathologist of the hospital. Rigor mortis only slightly developed. Body well nourished, brain only examined. Dressings when removed found to be stained with reddish serum, no pus about the wound, which was healing by first intention. There is a slightly elevated, semi-fluctuating tumor at the point of operation, pressure upon which causes disintegrated brain tissue to issue from the drainage tube at the bottom of the wound. There is an incised wound, nine and a half inches long, closed by sutures, beginning one inch in front and one inch above the left auricle, and passing upward and backward in a

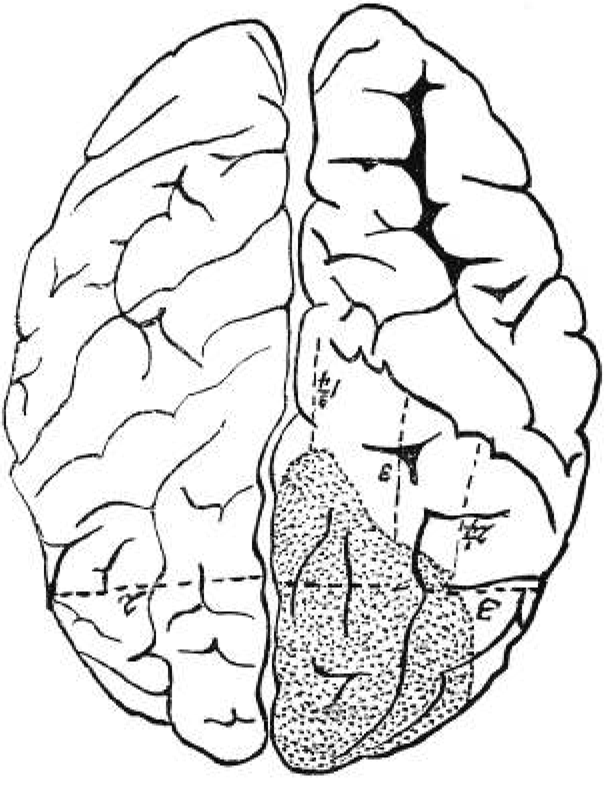

FIG. 3.—SUPERFICIAL RELATIONS OF TUMOR.

curved direction to within one and three-fourths inches of the sagittal suture, and thence downward to its point of termination four inches behind the auricle. At the anterior superior angle of the wound a button of bone is found adherent to the dura mater. Three other buttons are found lying upon the dura, non-adherent. Upon the removal of the calvarium, the dura mater appears normal except for a moderate venous congestion. In the left occipito-temporal region, about two and a half inches from the median line, is an opening in the dura, two and three-fourths by three inches, partially covered by two flaps of dura mater. In the interval between these flaps there protrudes a considerable mass of softened brain tissue. The weight

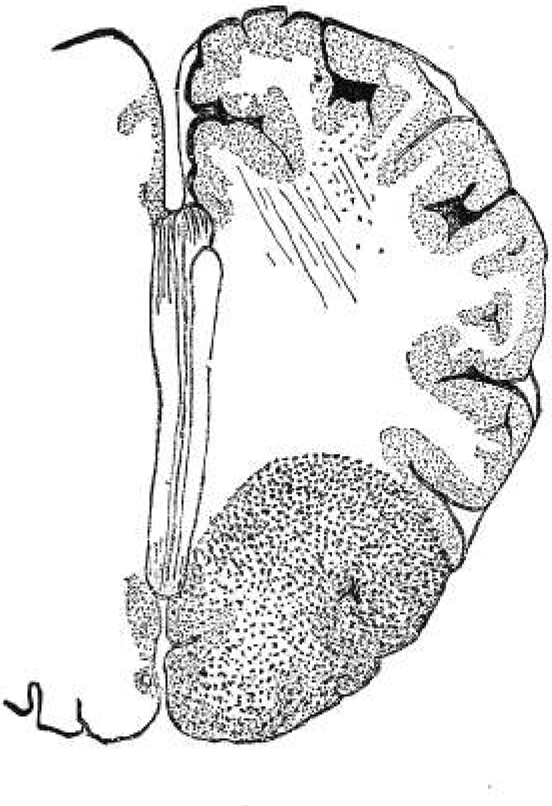

FIG. 4.—HORIZONTAL SECTION OF BRAIN AT LEVEL OF CORPUS CALLOSUM, SHOWING DEEP RELATIONS OF TUMOR.

of the brain is 1570 gms. not including that lost during the operation. There is a moderate congestion of the dura mater on the right side. The convolutions over the anterior half of the left hemisphere are greatly flattened and this portion of the brain is occupied by a non-encapsulated translucent mass, the outer portion of which is somewhat denser than the surrounding brain tissue, but its centre is softened and partially broken down. In the occipital lobe is a large, softened and disintegrated area beneath the site of operation. The subarachnoid space at the base contains a fresh clot which extends up into the Sylvian fissure on the left side, the pia mater of which region presents considerable diffuse ecchymosis. The antero-posterior diameter of the left hemisphere is $8^3/_4$ inches. Of the right $8^1/_4$ inches. The width of the left hemisphere is at widest part, $3^1/_4$ inches. Of right hemisphere 2 inches. The following surface measurements were made on the fresh brain: 1st. Distance of the posterior border of the tumor from intersection of fissure of Rolando with mesial surface, along line of junction of mesial and lateral surfaces, is $1^3/_4$ inches. 2d. One inch from central fissure and parallel to above line, 3 inches. 3d. From a point on the fissure of Rolando $2^1/_2$ inches from its superior ex-

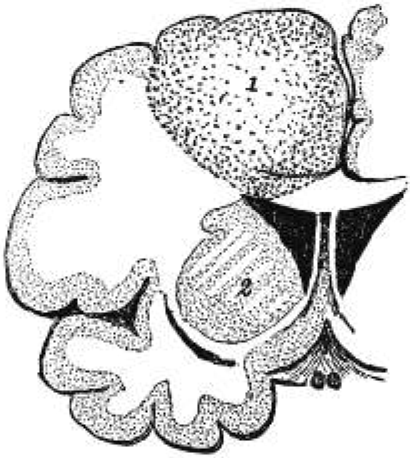

FIG. 5.—TRANSVERSE SECTION OF BRAIN, SHOWING RELATIONS OF TUMOR TO THE LATERAL VENTRICLE AND CAUDATE NUCLEUS.

1. Tumor.
2. Caudate Nucleus.

tremity, $2^1/_4$ inches. 4th. From the junction of the two arms on the Sylvian fissure, 4 inches. (See diagrams, Figs. 3, 4 and 5). The third frontal convolution, (left), which abuts against the fissure of the island of Reil is softened. The roof of the left lateral ventricle is wider at its anterior half than that of the other side and is bulged inward over the base of the tumor, which extends to within one-half inch of the ependyma. The caudate nucleus is flattened on the left side, *i. e.*, $^1/_8$ inch from the roof of the ventricle to the internal capsule. On the right side $^1/_4$ inch.

Microscopical Examination.—The softer portion of the tumor composing about two-thirds of its bulk is made up of nucleated branching cells, closely packed together with but scanty connective tissue stroma. Many of the cells freshly teased, have from ten to twenty or more prolongations, often of very considerable length. The tumor seems to be poorly supplied with blood vessels; the denser portion is made up of brain tissue infiltrated with these spider cells. This infiltration of the brain tissue with tumor cells involves a considerable area, but the infiltration is probably not sufficiently dense to entirely abolish the functions of the parts involved The nature of the growth is therefore gliomatous. Sections made from that portion of the brain removed at the operation show laceration and bloody infiltration, but no structural lesions. Sections from the necrotic portion removed post-mortem, show superficial softening consisting of fatty and granular changes in the cells and a deeper infiltration of the tissue with blood cells. The vessels of the pia mater are distended with blood and here and there are extravasations of blood in the meshes of the pia. The first temporal and third frontal convolutions show no lesions. The caudate nucleus of the left side, although somewhat flattened has essentially the same appearance as the right. The pineal gland contains a considerable number of corpora amylacea.

REMARKS.—Attention cannot fail to be first arrested by the extent to which the site of external injury proved to have been misleading as a guide to the location of the cerebral disease. That there existed a connection between the production of the tumor and the injury to which it was consequent is, however, not at all the less probable, for no fact is better established than the possibility, even frequency, of lacerations of brain tissue being produced by cerebral commotion resulting from blows upon the head at a point distant from the place of brain injury.

The degenerative cerebral changes, although in the frontal lobes, probably had as their exciting cause the blow at the back of the head sustained in the fall from the carriage in 1884. The possibility of such a distant lesion was clearly present in my mind previous to the operation, and was discounted by me beforehand in whatever expectations were indulged as to the probable success of the operative attack, but I, nevertheless, deemed myself justified in making the effort I did as long as there remained even a strong probability that the site of the external injury was the index to the location of the internal disease. In this determination I was strengthened by the opinion of the consulting neurologists that the localizing symptoms, though too indefinite to warrant them in distinctly localizing the disease, still did not contra-indicate its presence in that region of the brain. I was still further encouraged to give the benefit of the doubt to the region under the scar by the remarkable case reported by Keen (*Am. Jour. Med. Sci.*, Oct. '88, 329), in which an opening made through the cranial vault at the site of a small external scar in the scalp only, which was believed to mark the site where a blow had been received many years before, brought him directly down upon a large fibroma, adherent to the dura, but easily enucleated from the brain tissue in which it was imbedded.

A second point worthy of remark is that the tumor, even if it had been exposed, was not susceptible of complete removal. There is but little clinical experience yet as to the behavior of gliomatous tumors after their partial removal. The Bennett-Godlee case (1884) was a glioma (*Lancet*, 1884, II. p. 1090, 1885, I. p. 13). It was small (walnut-sized), and being hard, was easily enucleated. The autopsy, which followed the death of the patient from septic meningitis on the twenty-eighth day, showed that all the disease had been removed. In the Hirschfelder-Morse case (1886) (*Pacific Med. and Surg. Jour.*, April, 1886, p. 210) an infiltrating glioma, similar to my own, was encountered; a part only was excised. Death on the seventh day from encephalitis (septic evidently) closes the record of the case. There is a fair opportunity to differ with Dr. Hirschfelder's opinion that the unfavorable result in his case must be ascribed to the character of the tumor, and that if the case had been one of a hard tumor that could have been easily isolated, a greater probability would have been presented of the patient's recovery from the operation. On the contrary, there is no reason to believe that the danger of septic infection would have been any less in the latter than in the former case.

In the Suckling case (1887) (*Lancet*, Oct. 1, 1887) an infiltrating glioma of the cerebellum was found on autopsy. Part of the cerebellar substance had been cut away in the operative procedures, but it does not appear that the tumor was reached by the surgeon's knife. The patient lived but forty-eight hours after the operation.

In one of Horsley's cases (1886) (*Brit. Med. Journ.*, April 23, 1887) a firm glioma weighing 4½ ounces was removed along with a surrounding zone of brain tissue. Good recovery ensued, with relief to the symptoms for 2½ months, when rapid return of the growth took place with death at the end of 6 months from time of operation. It is altogether probable that in this case the removal of the gliomatous degeneration was not complete, but that the zone of the infiltration extended beyond the parts removed by the surgeon, and by the development of this residue the future symptoms and the final lethal termination were produced.

There is no reason to suppose that the partial removal of a gliomatous mass would entail any danger greater than would inhere in its complete removal, or in the complete removal of a circumscribed growth.

Its rapid recurrence is probable, and temporary relief by the removal of the pressure symptoms caused by its original bulk is the only advantage to be looked for from any attack upon it which falls short of the removal of every portion of brain tissue that is infiltrated with its peculiar elements.

The failure to accurately localize the growth in the case now reported, while it is to be deplored, has, nevertheless, its valuable lessons, and every case of the kind, if minutely studied and faithfully reported, will be helpful in preventing similar errors in the future. The indefiniteness of the symptoms which have thus far been identified as produced by lesions of much of the frontal and occipital lobes is such that thus far these fields remain in a nebulous state, as far as any reliable indications are concerned which may direct surgeons in attacks upon them. In illustration see the case of Bennett-Gould, 1886 (*Brit. Med. Journ.*, 1887, I, 12), in which, in the case of a man of 36 years, the lesion was located in the angular gyrus, and trephining was done at the site of a cicatrix from an old injury, $3^1/_2$ inches from the median line and $2^3/_4$ inches back of the meatus, a point approximating very closely that chosen in my case, in which the measurements were respectively $2^1/_2$ inches and $2^3/_8$ inches. Nothing abnormal was found here, however, neither superficially nor upon deep exploration. The patient made an uninterrupted recovery, and, strange to say, for five months after the operation, when the case was reported, had not had a fit.

It might be said in passing, however, that symptoms recognized as sufficient to localize lesions in the special motor centres about the fissure of Rolando have already in repeated instances been found misleading. As for example, the case reported by Birdsall and Weir in 1887 (*Med. News*, March 5, 1888, p. 273) where the tumor was supposed to be at the upper portion of the Rolandic fissure; a large opening through the cranium and dura was made at this point, through which the brain at once bulged, but exploration revealed nothing. The protruding portion of brain was sliced off and the wound closed. The patient lived two months and a half, and on autopsy a sarcomatous tumor was found springing from the left lobe of the cerebellum and extending down into the spinal canal crowding upon the medulla. Also one of Horsley's cases (1886) in which a diagnosis of a lesion of the left motor cortex having been made, the child was trephined, the brain incised for exploration, but nothing was found. The patient recovered from the operation without drawback, and was improved in his general health afterward, (*Brit. Med. Jour.*, April 23, 1887.) Also the case reported by Drummond (1887) in which the facial centre was diagnosticated as the subject of lesion. An opening was accordingly made here, but nothing abnormal was discovered. The patient survived but a few days, and the autopsy revealed an abscess in the posterior part of the frontal convolution, (*Lancet*, Oct., 1887, p. 656.)

The most recent case reported by Keen (*Med. News*, Dec. 1, 1888) illustrates again the uncertainties which may attend operative attacks on the brain. This experienced and careful surgeon and neurologist made a positive diagnosis of abscess of the temporo-sphenoidal lobe, and for very good reasons excluded meningitis, in a child under his care. He accordingly trephined over the spot localized; healthy brain bulged into the opening; multiple exploratory punctures with hypodermic needle and a grooved director were negative in their results. The child died on the fourth day after the operation, and the autopsy revealed a healthy brain, but with ventricles distended with serum the product of a tubercular meningitis!

Weir, in a recent paper (*Amer. Jour. Med. Sci.*, Sept. 1888, 227) calls attention to the difficulties which beset the question of accurate localization of intracranial lesions, and refers to three cases in addition to his own, referred to above, which have recently occurred in the experience of New York surgeons, in which the cranial wall has been perforated without finding any disease. With the impetus which has lately been given to the subject of brain surgery by Macewen and Horsley in Great Britain, and by the recent discussions at the American Congress of Physicians and Surgeons in this country, it is certain that operative efforts for reaching and relieving intracranial lesions will rapidly multiply and it is as certain that a considerable proportion of failures will be met with. Probably for a time the proportion of failures to successes will be greater than they have been thus far.

Out of this experience, failures quite as much as successes, is to be gathered knowledge which will be of great value in making our future work in this field more certain.

The operative technique involved in attempts to remove tumors of the brain has been very thoroughly gone over by Horsley, Weir, Keen and Park, and my own operation was conducted on the lines laid down by them. That the asepsis was complete was shown by the results of the autopsy which revealed primary union over a considerable extent of the wound, with no pus in any part of the operated field, even when subjected to rigid microscopical search. An attempt to control the expected profuse hæmorrhage from the extensive primary scalp incision by encircling the head by two or three turns of an elastic bandage horizontally below the line of the incision was a complete failure. The rapidly made incision was followed by abundant bleeding from many parts, which, however, was quickly and satisfactorily controlled by the pressure forceps, and the mass ligatures, applied as shown in the cut. Another time I should waste no time with the elastic bandage. In trephining I had two instruments, a larger 1 inch diameter trephine of the old crown pattern, and a smaller $^3/_4$ inch conical one. They both functioned well, but the rapidity and ease with which the latter instrument cuts its way through the bone was much greater than that of the former. For this reason, entirely apart from the greater security against undesired injury to the underlying tissues, I should prefer conical instruments for future use.

Hæmorrhage from the vessels of the dura was entirely prevented by passing a curved needle armed with catgut under them and tying them on the proximal side of the incision before dividing them. In the latter stages of the operation one or two arterioles of the pia, that were severed when the protruding brain mass was sliced off, gave me annoyance from the difficulty of applying ligatures to them. This was due not only to the delicacy and fragility of the tissue, but also to the fact that by that time the prolonged labor of the operation had rendered the hands of the operator less steady than they would have been earlier in the operation. Morphia had been given before the operation, and an 8% solution of cocaine was applied locally for its hæmostatic effect, but neither of these agents could be expected to materially affect vessels of any size. They certainly produced no apparent effect in this case. It will be noticed in the history that extensive explorations were made for the purpose of examining the deeper brain tissues by the use of a fine trocar and sharp needle. In making these explorations as extensive as they were, I relied not upon my own judgement alone, but also upon the advice of the experienced neurologists who were associated with me in the case. In connection with these punctures, however, we cannot fail to remember that at the autopsy there was found a considerable amount of fresh clotted blood in the subarachnoid space at the base of the brain, and that this clot was traceable upward into the Sylvian fissure and that there was connected with it likewise over a considerable territory more or less submeningeal ecchymosis. There is but little doubt that this hæmorrhage was the result of the puncture of some of the vessels passing up the Sylvian fissure. Dr. Hodenpyl, in conducting the subsequent careful examinations of the brain, injected these vessels but was unable then to find any point through which the blood in fact escaped, but, nevertheless, I think there can be no doubt that the source of this hæmorrhage was the puncture of some of these vessels by the exploring needle. How large a part this subarachnoid hæmorrhage played in producing the final symptoms which terminated in death may be a subject of question, but it is my conviction that it played a considerable part in it, and that the final œdema of the lungs and the respiratory failure may fairly be referred to the pressure of this subarachnoid clot. The case illustrates the danger of the use of a sharp instrument in making these deep explorations.

Attention has already been called to these possible dangers in the writings of others.

Weir, in his remarks upon the subject, speaks of the possible dangers connected with the use of a fine needle, and says that he knows of two fatal results that are referable to such explorations.

Keen, likewise, speaks of possible evil results, although in one of his cases, his last case, he did not hesitate to thrust in an hypodermic needle quite freely when he believed there was an abscess.

In a recent case published by Dr. Deaver, of Philadelphia, in an attempt to remove a supposed tumor of the spinal cord, a fatal result was produced, and in his remarks upon the case the doctor attributes the fatal result to wounding of the phrenic centre by an exploring needle which was used. These cases sufficiently demonstrate the danger of a sharp exploring needle, and in another case I should confine myself entirely to the use either of an ordinary fine probe or a grooved director, not too large.

A last point—the behavior of the buttons of bone after being replaced. It will be noted as a matter of considerable interest that one of these buttons of bone, at the end of thirty-eight hours had become quite firmly adherent to the dura upon which it was placed. This illustrates the possibilities of replacement of large masses of bone, particularly about the cranial vault and their becoming adherent and retaining life and becoming again incorporated into the cranial substance, and is an excellent illustration of the teachings which we owe primarily to Macewen, and which have been taken up so zealously by Keen, of Philadelphia. It is true that others who have attempted the practice have reported failures in securing the revivification of these bone buttons. The fact, however, that in some cases failures take place, does not militate against the desirability of making the attempt. If the bone button is preserved sterile and is replaced, if vascular connections fail to be established, it remains simply as an inert mass which at a later time may be removed; meanwhile the possibility of its forming new connections has been taken advantage of; if, on the other hand, it should have become adherent, and the life of the patient should be prolonged, it would certainly be to his advantage. It seems to me, therefore, that we may soon look upon the attempt to re-implant these bits of bone as a recognized tenet of surgery in connection with attacks upon the cranial vault.